# Transitioning Results from Recent ONR WESTPAC Field Programs to Operational Use

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## LONG-TERM GOAL

The long-term goal is to enhance our understanding of coastal oceanography by means of applying simple dynamical theories to high-quality observations obtained in the field. My primary area of expertise is physical oceanography, but I also enjoy collaborating with biological, chemical, acoustical, and optical oceanographers to work on interdisciplinary problems. I collaborate frequently with numerical modelers to improve predictive skill for Navy-relevant parameters in the littoral zone.

## OBJECTIVES

a) Continue analyzing recent data sets from the Western Pacific operating region (WESTPAC) and facilitate transitioning these basic research outcomes to operational use.

b) Improve our understanding of the circulation in the western Subtropical Countercurrent (STCC) and its impact on the neighboring boundary currents and downstream variability in the western North Pacific Ocean.

## APPROACH

Over the past fifteen years, ONR has organized several major field efforts in the WESTPAC region. The PI has personally organized, participated in, and published results from several of these areas including the Japan Sea, the East China, the South China Sea, and the Luzon Straits. Ongoing work continues in the eastern and western South China Sea and the Philippine Sea. All of these programs have identified oceanographic features with sufficient strength, persistence and spatial extent to have identifiable impacts on acoustic propagation and therefore tactical ASW exploitation. Examples of such features include the north wall of the Kuroshio current, westward propagating mesoscale eddies, surface mixed layers of varying strength and extent, and high-frequency non-linear internal waves. Coincident modeling studies during the field efforts demonstrated that Navy models can reproduce these features with some degree of forecast skill, thus facilitating their inclusion in tactical planning via the NAVO ASW reach-back cell. This grant is to continue analyzing recent data sets and facilitate transitioning these basic research outcomes to operational use.

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## WORK COMPLETED

A substantial effort in the grant is to work with the acoustics community (Peter Worcester, SIO; John Colosi, NPS; many others) analyzing the oceanographic data from several moorings deployed in the central Philippine Sea. The primary purpose of the program is to characterize and understand the acoustic propagation, but the hundreds of oceanographic instruments deployed also make the moorings conducive to basic ocean circulation studies. During April 5 – May 10 2009, two moorings were deployed, one source and one receive, with many temperature (T) and salinity (S) instruments along the mooring lines and an upward-looking acoustic Doppler current profiler (ADCP) near the top of each (Figure 1). During 2010-11, seven similarly-instrumented moorings were deployed in a star pattern spanning roughly 17 – 23°N by 23 – 130°E. The excellent spatial coverage of the PhilSea 2010-11 array will allow study of the highly-energetic STCC eddy field (Figure 2) as well as the ambient water mass properties. The acoustics team successfully recovered the moorings during April 2011. Data processing from the 2009 moorings is now complete while the 2010-11 data processing is still underway.

## RESULTS

The dominant signal in the 2009 pilot study data was the baroclinic tide whose amplitude regularly exceeded 50 m and sometimes was as great as 100 m. An interesting feature of these time series is that the maximal tidal currents and displacements lagged the lunar cycle by about 6 days. This is consistent with the mode-1 baroclinic tide propagating into the region from elsewhere. While the 2010-11 data can further illuminate this subject, the result is not inconsistent with the internal waves propagating from the Luzon Strait at order 1 m/s. No high-frequency nonlinear internal waves or solitons were observed in the 2009 data set. One low-frequency event was observed, but the pilot study records are too short and sparse to say much about the mesoscale eddies.

During the main field program, five of the six ADCPS obtained full records and the sixth a partial record. In the main, the TSP instruments worked well. Several of the new pumped SBE37 MicroCATS had problems, but the manufacturer seems to have recovered most of the data. Altogether the data return looks excellent. These instruments are still being processed and quality controlled. No scientific results are yet available.

## IMPACT/APPLICATION

This experiment is expected to break new ground in the field of blue-water deep-sea acoustic propagation. The array is also the first of its kind in region of the STCC, one of the most energetic mesoscale eddy regions of the world. Observing the eddy energetics and propagation speeds and directions will improve the quality of the oceanographic and acoustic nowcasts and forecasts.

## TRANSITIONS

The program is just beginning and there are no transitions at this time.

## RELATED PROJECTS

Peter Worcester, Scripps Institution of Oceanography, project leader

John Colosi, Naval Postgraduate School, deep water acoustics
Bruce Cornuelle, Scripps, mesoscale modeling
Brian Powell, University of Hawaii, mesoscale modeling
Brian Dushaw, APL/UW, internal waves
Coupled COAMPS transition team, Mark Swenson (FNMOC) and Frank Bub (NAVO), team leaders

**PUBLICATIONS**

None at this time

| 2009 | | 2009 | |
|---|---|---|---|
| Depth | Instrument | Depth | Instrument |
| 350 | ADCP (150-kHz) | | |
| 100 | SBE37-SMP | 680 | SBE37-SM |
| 130 | SBE37-SMP | 730 | SBE37-SM |
| 160 | SBE37-SMP | 800 | SBE37-SM |
| 190 | SBE37-SMP | 870 | SBE37-SM |
| 220 | SBE37-SMP | 940 | SBE37-SM |
| 250 | SBE37-SMP | 1020 | SBE39 |
| 280 | SBE37-SMP | 1110 | SBE39 |
| 320 | SBE37-SMP | 1220 | SBE39 |
| 360 | SBE37-SMP | 1340 | SBE39 |
| 390 | SBE37-SMP | 1480 | SBE39 |
| 440 | SBE37-SMP | 1650 | SBE39 |
| 480 | SBE37-SMP | 1860 | SBE37-SM |
| 520 | SBE37-SM | 2160 | SBE39 |
| 570 | SBE37-SM | 2640 | SBE39 |
| 620 | SBE37-SM | 5000 | SBE37-SM |

***Figure 1. Instrument placements during the PhilSea 2009 Pilot Experiment, April-May 2009. (Table courtesy of John Colosi, Naval Postgraduate School.)***

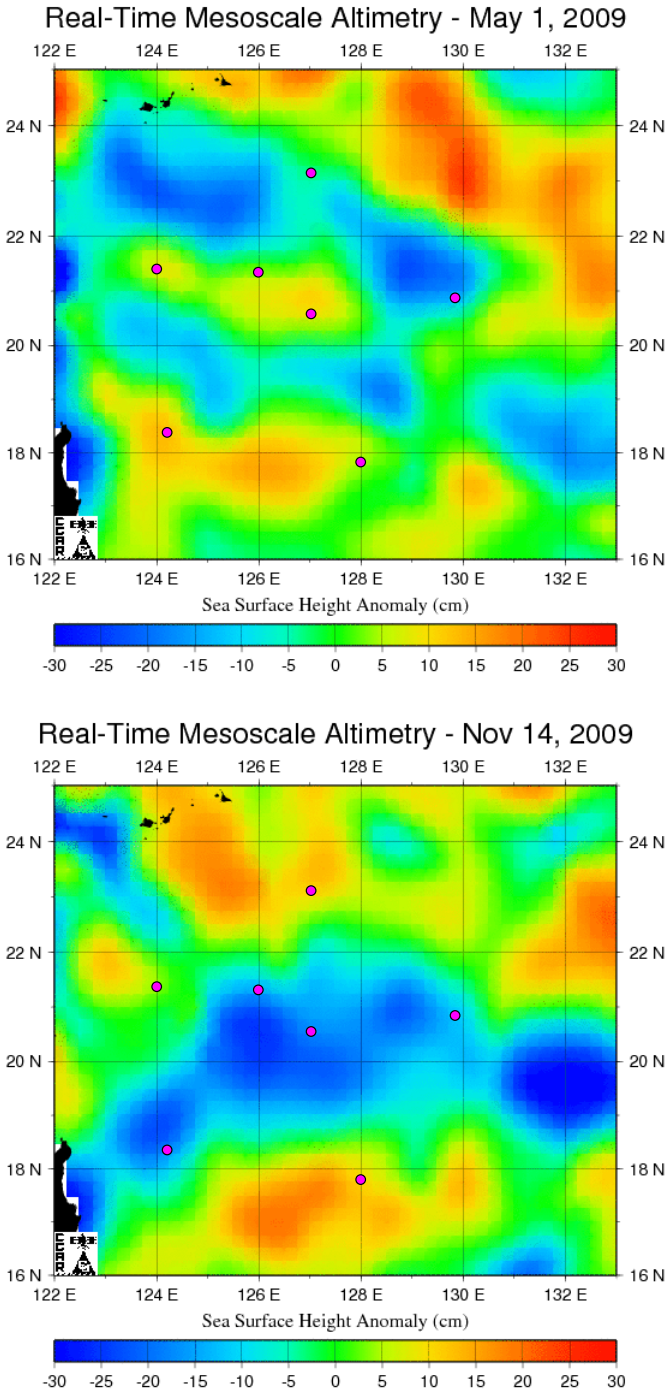


***Figure 2. Recent sea surface height (SSH) anomalies from the satellite altimeter on May 1 (top) and Nov. 14, 2009 (bottom) with the PhilSea10 mooring positions superimposed as magenta dots. (Mooring positions courtesy of Peter Worcester, SIO.)***